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Strategies to combat centralized sewer overflows

Many cities and communities are developing solutions using a variety of approaches to prevent combined sewer overflows (CSOs). **Dennis Hallahan** of Infiltrator Water Technologies explains several ways to manage CSOs, including the use of decentralized systems to attenuate flow, reduce stormwater volume, prevent CSOs, and improve water quality.

Above: Construction of the engineered wetland included a liner and underdrain system. The 11-hectare (27-acre) system will provide treatment for CSOs and bring the city within permit discharge limits. Photo by Infiltrator Water Technologies

Stormwater infrastructure plays a critical role in cities and communities worldwide, conveying large volumes of water to protect local infrastructure from surface flooding. In the United States (US) and almost every other country, the stormwater infrastructure is required to serve double duty by handling both stormwater and sanitary sewage. These combined sewers convey the everyday sanitary sewer volumes and then, when it rains, the stormwater volumes as well, which can lead to CSOs.

The US Environmental Protection Agency (EPA) published a report in 2001, which estimated CSO volumes in the US of 1.3 trillion gallons (4.9 trillion liters) per year. Nearly 50 years after the Clean Water ACT (CWA) passage, US communities continue to be in violation resulting in EPA enforcement actions.

Centralized treatment systems must contend with the problem of Infiltration and Inflow (I&I). This contributes to overflows – both with CSO and sanitary sewer overflows (SSO) – and direct discharge of untreated waste during rainfall events when the capacity of the sanitary sewer piping and/or the capacity of the wastewater treatment plant may be exceeded.

According to the EPA's 2004 Report to Congress: Impacts and Control of CSOs and SSOs, the number of US communities with stormwater utilities or fees has grown from approximately 1,400 in 2013 to 1,600 in 2016. In approximately 772 US communities, wastewater and stormwater drain into the same combined sewer system and in most communities this infrastructure piping is too costly to replace. In April 1994, the EPA issued the CSO Control Policy, the national framework for control of CSOs, through the National Pollutant Discharge Elimination System permitting program. It mandates the dramatic reduction or elimination of CSOs, so the EPA began working with municipalities to improve antiquated sewage systems.

The effects of CSOs

CSOs can significantly impair water quality and impact public health and wildlife. After non-point source pollution such as agricultural runoff and stormwater, CSOs are a leading source of water pollution in the US. Communities with extensive impervious surfaces such as parking lots, roofs, and sidewalks are particularly vulnerable. CSOs flood waterways and coastal watersheds with contaminants including microbial pathogens and toxins that can be present at levels that present a risk to human and environmental health. Additionally, these CSOs may contain nutrients that deplete dissolved oxygen killing resident aquatic life, chemicals, trash, and suspended solids. A 2016 EPA report to Congress on CSOs in the Great Lakes Basin states that there were 1,482 CSO events in 2014 with an estimated discharge at 22 billion gallons (83.3 billion liters) of untreated wastewater within the 184 communities that discharge CSOs in the area. With CSOs continuing to occur frequently, engineers and municipalities are working to develop solutions that will handle these large flows and protect property, residents, and the environment.

Using decentralized strategies to combat CSOs

Capturing runoff where it falls in urban settings remains one of the primary goals in reducing CSOs, however given the urban setting this can be difficult as open land area can be in short supply and wet-weather water management can be difficult for communities faced with the challenge of discharging large volumes of minimally treated wastewater. Engineers and designers are discovering that the decentralized model meets community needs at a cost communities can afford.

IN LIEU OF BUILDING MORE PIPING OR LARGER WASTEWATER TREATMENT PLANTS, ENGINEERS ARE SPECIFYING DECENTRALIZED METHODOLOGIES SUCH AS ENGINEERED WETLANDS TO MANAGE CSOs.

The future engineered wetland site is seeded with specific species of vegetation that will thrive in the wetland environment and allow evapotranspiration and nutrient uptake. Photo by Infiltrator Water Technologies

The decentralized approach can meet multiple CSO objectives including flow rate attenuation, volume reduction, and water quality improvement. The Water Environment Research Foundation (WERF) published a report in 2006 titled, "Decentralized Stormwater Controls for Urban Retrofit and Combined Sewer Overflow Reduction." This report supported the use of decentralized source controls in conjunction with redeveloping land in urban regions. Over time, this approach creates opportunities to develop greener communities that achieve higher levels of ecological and receiving water protection.

In lieu of building more piping or larger wastewater treatment plants, engineers are specifying decentralized methodologies such as engineered wetlands to manage CSOs. Bioretention systems provide added capacity to existing centralized systems and offer aesthetic and sometimes recreational benefits. For example, these systems are an adaptable alternative that can be designed into roadway or parking lot median strips that include native plants with a sand or gravel filtration layer below that may also have a liner to allow for stormwater capture and reuse. This type of green infrastructure may even reduce air pollution and lower air temperatures minimizing urban heat island issues and providing native habitats for plants and animals.

Other CSO management approaches

Separate the waste at the source. Separating storm and sanitary sewers is one solution; however it can prove very costly. A mid-sized US city with a population of less than 250,000 may have a wastewater utility district with over 805 kilometers (km) (500 miles) of sewer piping and approximately half of that may be combined sewers. The cost of upgrading and separating 402.5 km (250 miles) of sewers is not financially feasible.

Allow CSOs, but treat the overflows. In this approach, overflows are directed to containment facilities including tunnels or underground detention facilities. Treatment methods, including reverse osmosis and ultraviolent light, enable faster processing than chlorine methods. Lower processing and holding time allow wastewater plants to process greater volumes and discharge cleaner wastewater. The treated stormwater can also be collected and reused in commercial or industrial applications or for irrigation.

Blending. Blending or bypassing is regularly used by sewerage operators to manage peak flows. The utility routes a portion of peak wastewater flow around the biological treatment units, then combines those flows with the wastewater that received biological treatment. Usually following the blending process, the effluent is disinfected and discharged into water bodies. Though this approach has been used for decades, its efficacy is being questioned by public health officials, environmental groups, and the wastewater industry because it allows for concentrations of pollutants to be released into water bodies.

Long-term planning. Most metropolitan areas have regulations requiring developers to install separated sewers for any new development. This controls new inflow into the sewer system but does not prevent historic CSO issues. Community long-term planning incorporating decentralized concepts could provide additional effective, sustainable solutions.

Urgency and need grows with rain events

While governments provide some funding for wastewater and stormwater infrastructure improvements, most funds are generated at the state and municipal level. Billions of dollars will be needed by local communities in the US alone just to meet federal regulations. As communities continue to grow and rain events become more intense, the need to enhance capacity of the wastewater and stormwater management strategies and treatment systems takes on additional urgency. And, while water scarcity worldwide rises as the greatest challenge of our time and, innovative approaches to reusing stormwater needs also to be given high priority, this investment needs to materialize sooner rather than later.

Author's Note

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Decentralized solution saves millions, reduces flooding

In Washington, Indiana, a decentralized solution cleans up a polluted waterway, saves tens of millions of dollars in construction cost, and lowers operating costs

In the US city of Washington, Indiana, the centralized infrastructure, built in 1930, was old, decaying, and had minimal storage capacity. As little as one-tenth of an inch of rain produced CSOs and between rain events the water pooled and dried up, concentrating pollutants. Early attempts to abate the pollution by enclosing drainage ditches and creeks in large pipes didn't address overall water quality and the city faced federal mandates to clean up its water. Conventional, centralized solutions with price tags of US$53 million or more were proposed but deemed not viable given the financial burden to the city's 12,000 residents.

Following extensive discussions between city officials, project engineer Bernardin, Lochmuller & Associates, and the Indiana Department of Environmental Management proposed a decentralized solution featuring a constructed engineered wetland. This approach had a significantly lower capital cost, saving Washington residents approximately $26 million as compared to the second choice Chemically Enhanced High Rate Clarification system. The decentralized solution would save the city more than $1.6 million annually in operations and maintenance expenses, according to the project engineer. Additionally, the diversion of stormwater would reduce flooding of nearby residences and roadways during rain events.

Engineered wetlands employ vegetation as part of the treatment process and require minimal energy input. In the Washington wetland, wastewater is directed into a 15.1-million-liter (4-million-gallon) storage tank and then discharges to a treatment plant. Excess flow is released through two 213-centimeters (84-inch) culverts to the wetland itself, which encompasses 11 hectares (27 acres) of land. A supervisory control and data acquisition (SCADA) system determines how long the overflow stays in the wetland. Following treatment, the effluent passes through an ultraviolet disinfection system before discharging to the local creek. The new system includes tools for fine particle removal, an underdrain system to allow dewatering for maintenance purposes, and a recirculation system to control soil moisture to help with purification. A landscape plan includes specific plant species known for adaptability to changes in water level and soil moisture. Due to its depth, the wetland remains saturated even in times of drought and the natural geology of the area benefits plants and enhances nutrient uptake.